

Laparoscopic Surgery for Epiphrenic Esophageal Diverticulum

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ABSTRACT

Background and Objectives: We wanted to assess our surgical results focusing on the patients' quality of life. We present our experience with laparoscopic surgery for epiphrenic esophageal diverticulum. Short- and long-term results of surgical therapy were analyzed.

Methods: Eight patients were examined with a symptom-causing epiphrenic diverticulum. Patients underwent complex gastroenterologic examinations before and after surgery. Laparoscopic transhiatal epiphrenic diverticulectomy, Heller cardiomyotomy, and Dor anterior partial fundoplication were performed on 7 patients. One patient underwent only diverticulectomy, where no motility disorder was present. Results from surgical treatments and changes in patients' pre- and postoperative complaints were evaluated.

Results: In all cases except 1, the preoperative examination showed dysmotility of the esophagus. The average duration of the surgeries was 165 (130–195) minutes; blood loss was minimal. One patient developed bleeding in the early postoperative period, and a second laparoscopy was required. No other intraoperative complication was detected, and no mortality occurred. In one case, a staple line leak developed (1/8 [12.5%]), which was resolved with conservative therapy. Functional check-ups confirmed adequate esophageal function. The total symptom score for the patients was 6.3 points before surgery, and it decreased to 1.6 ($P < .001$) after surgery, an average of 74% subjective improvement. During the follow-up period (mean, 60 months; 10–138 months), proton pump inhibitor therapy was started in 4 patients to treat gastroesophageal reflux. In 3 cases, drug therapy was successful; in one case, Nissen antireflux surgery was performed.

Conclusion: Laparoscopic transhiatal diverticulectomy and Heller–Dor surgery are effective interventions with low morbidity. Patient quality of life significantly improves in the long term, but gastroesophageal reflux disease may occur.

Key Words: Epiphrenic esophageal diverticulum, Laparoscopic transhiatal surgery, Long-term results.

INTRODUCTION

Epiphrenic diverticulum of the esophagus is an outpouching of the mucosal and submucosal layers of the esophagus that generally affects the distal third segment of the esophagus. Lesions are considered to be pulsion type, as they are accompanied by dysmotility of the esophagus in 70 to 90% of the cases, known as primary esophageal motility disorder (PEMD).^{1–4} The most common motility disorders are achalasia and diffuse esophageal spasm; less common disorders are the so-called nutcracker esophagus and the hypertensive lower esophageal sphincter (LES). The disease is relatively rare, with a prevalence of between 0.0015% and 2%, thus explaining the limited number of studies in the literature. It is mainly large diverticulum and diverticulum associated with functional esophageal disorders that lead to symptoms; this is the case in up to 10 to 20% of patients.^{5–9} Symptoms may be variable: the most common include dysphagia, regurgitation of food, chest pain as a consequence of the diverticulum, and motor dysfunction of the esophagus.¹⁰ Surgical treatment is indicated only in the case of complaints,¹¹ although surgery may be performed to prevent imminent, often fatal complications (recurring aspiration and pneumonia), as well. For lesions that cause no or mild symptoms, conservative and endoscopic treatment may be considered if functional disorder of the esophagus is confirmed (such as gastroesophageal reflux disease [GERD], achalasia, and hypertensive LES).¹²

Surgical treatment consists of resection of the diverticulum and, usually, cardiomyotomy. The latter should be complemented with antireflux surgery (Dor or Toupet) to reduce postoperative GERD, which occurs in a large number of cases. Standard explorations of the esophagus (tho-

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racotomy and laparotomy) are accompanied by significant morbidity. To reduce morbidity, minimally invasive surgery has become widely used in the functional treatment of the esophagus and in the surgical treatment of epiphrenic diverticulum. Currently, transhiatal diverticulectomy with cardiomyotomy and antireflux surgery are the most commonly used surgical techniques. In addition to the low morbidity of the method, patients become asymptomatic and the intervention provides effective symptom control in 80 to 90% of cases, although publications are limited with regard to long-term results.

In our publication, we analyze our experience in laparoscopic transhiatal diverticulectomy successfully used for the surgical treatment of epiphrenic diverticulum, with a focus on long-term changes in quality of life.

MATERIALS AND METHODS

Between January 1, 2003, and March 1, 2016, 8 patients (4 men, 4 women; average age: 63 [52–76] years) were treated at our department for symptomatic epiphrenic diverticulum. The most common complaint was dysphagia, which occurred in 87.5% (7/8) of the patients. Epigastric pain was experienced by 75% (6/8), and 50% (4/8) reported regurgitation. Moderate weight loss occurred in 62.5% (5/8) of the patients (**Table 1**). One patient had esophageal candidiasis in her medical history.

The average duration of complaints was 73 (4–360) months. After we obtained a thorough medical history from the patients, complex gastroenterological check-ups were performed (swallowing x-ray, endoscopy of the upper gastrointestinal tract, pH, and manometry of the esophagus). The average diameter of the diverticulum was 6.5 (3–12) cm before surgery. During the endoscopic examination, diverticula were found an average of 34.3

(32–38) cm from the teeth and 5 cm (3–8 cm) from the cardia. They opened mainly in the right, dorsolateral direction (right/left: 5/3). In addition to the diverticulum diagnosis, a small axial-type hiatal hernia was diagnosed in 2 cases. Manometry of the esophagus was performed in all cases. Normal LES with prolonged relaxation was detected in 2 patients (25%), and manometry confirmed achalasia in 2 cases (25%). The other 3 findings showed the following: LES with incomplete relaxation and spastic motor disorder (12.5%), incompetent LES (12.5%), and distal esophageal spasm with involvement of LES (12.5%). One patient had normal manometric findings. pH-metry confirmed abnormal postprandial acid reflux in 1 case (12.5%), and 50% of the patients had physiological findings (**Table 2**).

Surgical Treatment

Laparoscopic transhiatal epiphrenic diverticulectomy, Heller cardiomyotomy, and Dor anterior partial fundoplication were performed on 7 patients. One patient underwent only diverticulectomy, where no motility disorder was present. All the surgeries involved an endoscopic check as well. All removed diverticula were sent for histologic examination. Oral nutrition for the patients was gradually introduced after a negative swallowing test.

Laparoscopic Transhiatal Epiphrenic Diverticulum Resection

Patients were placed in 30° reverse Trendelenburg position while under general anesthesia. The surgeon stood between the patients' legs. Three ports were inserted in the abdominal cavity along the left costal arch 15 cm from each other, 1 port was placed in the epigastrium on the right side, and 1 port, 10 to 12 mm in diameter, was

Table 1.
Demographics and Preoperative Data

	Data
Demographics	
Gender (F/M)	4/4
Age (year)	63 (52–76)
Diverticulum characteristics	
Diameter (cm)	6.5 (3–12)
Distance from teeth (cm)	34.3 (32–38)
Distance from cardia (cm)	5 (3–8)
Open site, n (dorsolateral, right/left)	5/3

Table 2.
Motility Findings

Patient	Esophageal Manometry Finding
1	Normal esophageal and LES function
2	Achalasia
3	Normal pressure, prolonged LES relaxation
4	Normal pressure, prolonged LES relaxation
5	Incompetent LES
6	Incomplete LES relaxation, spastic motility disorder
7	Distal esophageal spasm with LES involvement
8	Achalasia

inserted directly above the umbilicus (camera port) (**Figure 1**). Intraoperative endoscopy was used to assess the level and clear the contents of the diverticulum. The abdominal and lower mediastinal segments of the esophagus were mobilized with a LigaSure device (Valleylab, Boulder, Colorado, USA) (**Figure 2**). Then the diverticula were dissected and removed with Endo-GIA (USSC, Norwalk, Connecticut, USA) blue cartridge (45 and 60 mm) (**Figure 3**). In 2 cases, complete removal required 2 cartridges (one 60 mm and one 45 mm), and in 1 case, 3 cartridges (45 mm) were needed. The integrity of the mucosal membrane of the esophagus was checked with intraoperative endoscopy during all surgeries. The specimen was removed with an Endobag (Medtronic Minimally Invasive Therapies, Minneapolis, Minnesota, USA) (**Figure 4**). After the diverticulectomy, a Heller esophagocardiomyotomy was performed on the opposite side of the proximal edge of the neck of the diverticulum in a segment 2 cm in length along the fundus, and then a Dor partial anterior fundoplication was performed.

Dor 180-Degree Anterior Partial Fundoplication

This procedure requires less mobilization of the stomach. The goal is to create a tension-free anterior gastric fundus. The construction of the Dor (partial anterior) fundoplication begins with the placement of a nonabsorbable suture that passes from the greater curve of the stomach to the left crus, close to its superior limit, and to the left myotomy edge. This suture is tied with an extracorporeal technique that forms the left edge of the fundoplication. Two rows of sutures are placed. The first row comprises 3 stitches: the uppermost stitch involves the

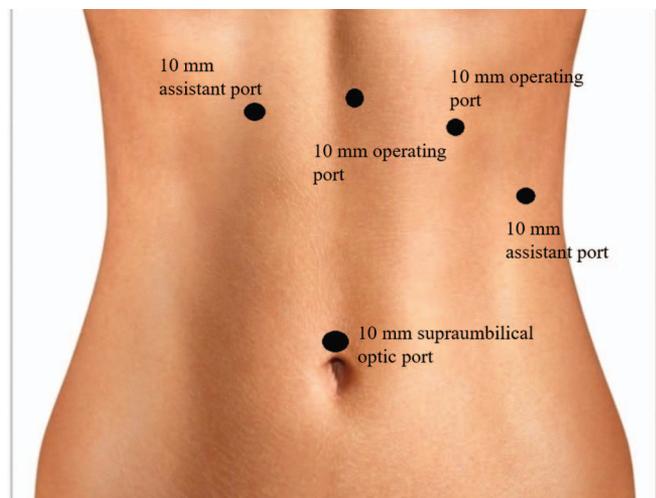


Figure 1. Standard port sites for laparoscopic surgery for epiphrenic esophageal diverticula.

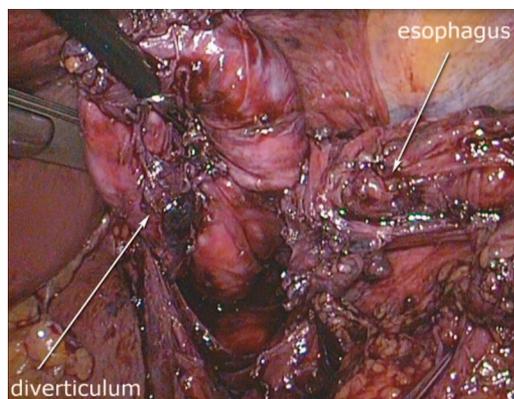


Figure 2. The diverticulum is fully mobilized using the transhiatal laparoscopic approach.

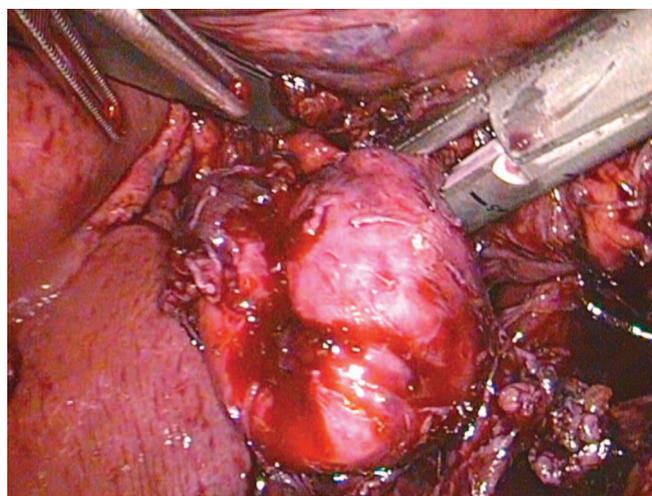


Figure 3. Approximation of the Endo-GIA to the diverticular neck.

gastric fundus, the esophageal wall, and the left pillar of the crus, and the other 2 involve only the gastric fundus and the left side of the esophageal wall. The gastric fundus is then folded over the myotomy, and the second row (also comprising 3 stitches) is placed on the right side between the fundus and the right side of the esophageal wall, with only the uppermost stitch involving the right crus. Finally, 2 additional stitches are placed between the anterior rim of the hiatus and the superior aspect of the fundoplication. These stitches remove any tension from the second row of sutures.

Patient Follow-up

The patients participated in a gastroenterological check-up an average of 3 months after surgery (swallowing examination, esophagus manometry, pH-metry, and

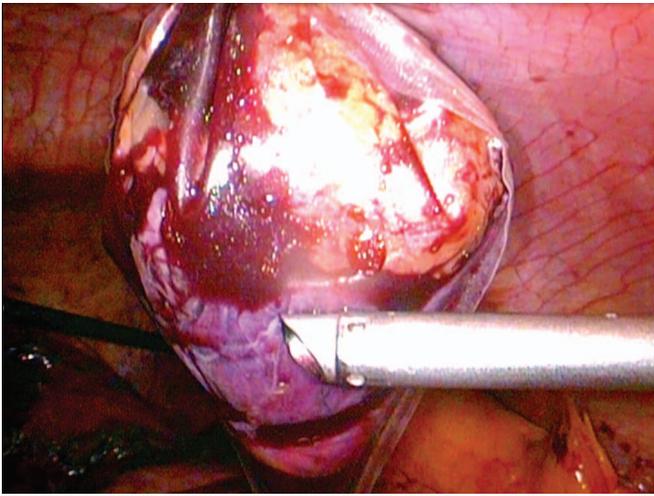


Figure 4. Removal of the resected epiphrenic diverticulum with an Endobag.

esophagogastroscopy). Follow-up examinations were performed on 6 patients, whereas 2 patients were not present at the scheduled follow-up visits after the initial phase of the follow-up period (2 and 6 months after the intervention), although both patients were asymptomatic.

Changes in quality of life with regard to symptoms related to esophageal function were evaluated in our long-term studies (mean, 60; 10–138 mo) (6 patients). A special questionnaire was prepared based on a scoring system published by Eckardt et al¹³ and modified by Zaninotto et al.¹² The score was determined before and after surgery.

We asked questions about the severity of regurgitation, dysphagia, and epigastric/chest pain since the symptoms had started. All the questions had 4 possible answers regarding the frequency of complaints associated with the esophagus (never, occasionally, daily, and at each meal). Answers were weighted. Patients who reported no symptoms received 0 points, and 1, 2, or 3 points were assigned in accordance with the frequency of complaints. The total number of points that could be received was 9. After the surgery, we were interested in the changes in complaints. Three additional questions were asked on the function of the vagal nerve (feeling full early and frequency of dumping episodes), the regular use of antacids, and change in weight.

Statistics

All statistical analyses were performed with SigmaPlot for Windows (ver. 12.5, 2011 Systat Software, Inc., San Jose, California, USA). Values of $P < .05$ were considered to be

statistically significant. The data were collected on an Excel spreadsheet (Microsoft, Redmond Washington, USA). Quantitative data are provided as means (\pm SD). The paired t test was used to compare pre- and postoperative cumulative mean symptom scores.

Ethics

The study was registered with the Regional Human Biomedical Research Ethics Committee with the identifier 3927.

RESULTS

Results of Surgeries

The duration of the surgery was an average of 165 (130–195) minutes with minimal blood loss (50–150 mL), and conversion was not necessary. One patient developed bleeding in the early postoperative period (through an abdominal silicon drain 3 h after the primary operation). Despite hemostatic medications, the bleeding did not stop and thus a second laparoscopy was required. There was active bleeding from the esophageal myotomy line, which was controlled with a high-energy device (LigaSure). No sign of postoperative bleeding was observed thereafter, and the patient recovered fully after the operations.

A swallowing test performed with the administration of a water-soluble contrast agent (diatrizoate meglumine) on postoperative day 4 confirmed leakage along the sutures in 1 case (1/8, 12.5%). Because the conservative treatment (zero diet, antibiotic therapy, and parenteral feeding) was not successful for 7 days, we decided to implant a jejunal feeding catheter to accelerate the healing process. After another 7 days of conservative treatment after the intervention, the fistula closed; thereafter, oral feeding was built up. There was no mortality. After a negative swallowing test, oral nutrition for patients was phased in gradually, and patients were discharged without any complaints. Average duration of care was 14 (8–41) days (**Table 3**). A histology of the diverticula showed no dysplasia or malignancy, but, in one sample, esophageal manifestation of Crohn's disease was confirmed. After the surgeries, functional tests were performed on 3 patients (gastroscopy, manometry, and pH-metry), which showed normal function. The other 5 asymptomatic patients refused all tests except gastroscopy.

Long-Term Results

Six patients (6/8, 75%) completed the questionnaires on long-term symptoms. The results were compared with

Table 3.
Perioperative Clinical Data

Perioperative Factor	Data
Operative time (min)	165 (130–195)
Blood loss (ml)	100 (50–150)
Conversion (n)	0
Intraoperative complications (n)	0
Staple line leak (n)	1
Complications requiring reoperation (n)	1 (bleeding)
Mortality (n)	0
Hospital stay (mean, days)	14 (8–41)

preoperative complaints based on thorough medical histories. A pre- and postoperative subjective “individual complaint score” was therefore determined.

The esophagus-related mean cumulative score before the intervention was 6.3 (3–9), and it decreased to 1.6 (0–5) after the intervention, which is an average of 74% ($P < .001$) subjective improvement (**Table 4**). Among the patients completing the questionnaire, 4 (66%) experienced weight gain, and none reported weight loss (0%). A symptom characteristic of dysfunction of the vagal nerve was detected in only 1 patient (12.5%) and was often associated with occasional early fullness. Proton pump inhibitor (PPI) therapy was started in 4 patients who had GERD develop after a 6-month (2–12 months) complaint-free period in the case of 4 patients. In 3 cases, complaints were resolved with drug therapy. In one patient, laparoscopic antireflux surgery (Nissen) was performed because conservative therapy has been ineffective, and the patient became completely asymptomatic by the first 6-month follow-up visit.

DISCUSSION

Laparoscopic transhiatal epiphrenic diverticulum resection by the Heller–Dor surgical method, which we use, is

an intervention with low morbidity and adequate long-term results comparable with international data. Partial insufficiency of mechanical suture was detected in 1 case (1/8; 12.5%), which was resolved with conservative therapy, and no perioperative mortality occurred. Patient follow-up lasted for an average of 60 months, quality of life improved significantly, and symptoms detected before surgery decreased to a minimum. Although half of the patients exhibited GERD symptoms, the reflux was controlled with drug therapy in 3 cases. Another surgical intervention (Nissen surgery) was necessary because of persistent symptoms in 1 case.

Before minimally invasive surgery, epiphrenic esophageal diverticulum was treated with a left thoracotomy; the morbidity and mortality of this procedure were significantly higher than with the laparoscopic approach.⁶ Currently, the laparoscopic transhiatal technique is one of the most commonly used minimally invasive procedures in the surgical treatment of an epiphrenic diverticulum. Morbidity from the intervention is minimal, and it provides symptom relief in 85 to 100% of cases. With a prevalence of 8 to 23%, staple line insufficiency is one of the most frequent and serious complications after an esophageal diverticulum resection. Mortality is low (0%–7%).^{10,14} In addition to the well-known advantages of laparoscopy (eg, less postoperative pain, and shorter hospitalization), other favorable factors to this procedure include the ability of the surgeon to explore the diverticulum thoroughly from the transhiatal direction, removed it easily with an Endostapler (Medtronic Minimally Invasive Therapies), and then perform myotomy and antireflux surgery in a technically adequate manner. Intraoperative endoscopy aids in identifying the diverticulum, in aspirating its contents, and in dissecting it correctly, as well. The safety of the surgery is significantly increased by an endoscopic check at the time of the resection and a check of the sutures after diverticulectomy.¹⁵ The laparoscopic method is not perfect in mobilizing the proximal segment of the esophagus, in preparing the cranial edge of the neck of

Table 4.
Esophagus-Related Symptoms: Change in Individual Complaint Scores

Symptoms	Preoperative Severity Mean Score (Points)	Postoperative Severity Mean Score (Points)	Symptom Relief (%)	<i>P</i>
Dysphagia	2.5 (0–3)	0.17 (0–1)	93.3	
Epigastric pain	1.83 (0–3)	0.83 (0–3)	55.5	
Regurgitation	2 (0–3)	0.66 (0–2)	66.6	
Mean (SD) cumulative score/patient	6.33 (±2.06)	1.66 (±1.86)	74	.001

the diverticulum potentially in the mediastinum, or in performing the proper myotomy. To avoid these limitations, robot-assisted surgeries are available and provide a perfect opportunity to perform the intervention, although availability of the method is currently limited.¹⁶

There are 2 important questions regarding minimally invasive surgery for epiphrenic diverticulum that should be discussed: the necessity of cardiomyotomy and antireflux surgery. The choice of surgical method is determined not only by the size of the diverticulum but by the associated motility disorder, as well; therefore, the removal of the diverticulum alone is not sufficient to prevent complications and to provide an asymptomatic condition. Effler et al¹⁷ and Belsey¹⁸ introduced the necessity of myotomy. The importance of dissecting the muscle layer of the esophagus was confirmed later¹ after a motility disorder was confirmed in 71% of the patients with the stationary method first and then in 100% of the patients with 24-hour manometry. Data in the literature confirm that suture insufficiency and the incidence of disease recurrence are more common after surgery performed without myotomy.¹⁹ A study conducted with 21 patients at the Mayo Clinic showed high rates of suture insufficiency and disease recurrence (24 and 19%, respectively) in patients without myotomy after diverticulectomy, whereas these sequelae did not occur in the myotomy group.²⁰ In our complicated case, preoperative investigations revealed no motility disorder; therefore, a laparoscopic transhiatal diverticulectomy was performed, but no cardiomyotomy. We carried out a complete resection of the diverticulum with 3 cartridges of 45-mm Endo-GIA (Medtronic Minimally Invasive Therapies). Our theory is that both the absence of cardiomyotomy and the step formation on the esophageal staple line caused by the multiple cartridges contributed to the staple line insufficiency. According to these results, cardiomyotomy should be considered to minimize staple line insufficiency in all cases.

The required length of the myotomy is still debatable. Long myotomy is well known,⁹ although several publications and our own data confirm the necessity of an intervention of 1.5 to 2.0 cm in length from the upper edge of the diverticulum to the proximal segment of the stomach.^{3,21–23} Other data suggest that the length of the myotomy should be the same as the extent of motor dysfunction.²⁴ In accordance with a North American study, in the case of achalasia and an epiphrenic esophageal diverticulum, myotomy without resection and partial fundoplication resulted in clear improvement in quality of life.²⁵ If a myotomy is necessary, surgery must be complemented with an antireflux procedure as well. Most surgeons prefer

partial fundoplication (Dor or Toupet), as this procedure avoids hypertension in the LES and decreases the incidence of GERD.²³ However, others recommend complete fundoplication, as their results show that this procedure does not increase postoperative dysphagia and provides better reflux control.^{3,26} Not all articles with long-term data mention postoperative reflux. We found 4 publications that covered GERD,^{3,24,26,27} with precise documentation and complete functional tests. Reflux disease occurred in only a few cases, irrespective of the type of fundoplication (Dor, Toupet, or Nissen). Rosati et al.²⁷ reported a patient who was prescribed a PPI for the symptoms (1/20).

We wanted to evaluate the success of our surgical interventions and changes in quality of life in patients with the patient-reported outcome (PRO) measurements used more commonly in clinical and pharmacological studies and healthcare analyses. PRO measurements include the HRQL (health-related quality of life) tests that analyze health condition-dependent dimensions of quality of life in individuals. The condition of our patient group was determined with an evaluation scheme similar to a scoring system based on a subjective evaluation of patients known as the “patient symptom score” with data gathered via questionnaires. This score was used by an Italian group for evaluating the outcome of epiphrenic diverticulum.²⁸ Questionnaire-based analyses have been used for several benign esophageal diseases. A publication by a Cleveland group should be noted²⁹ that compared quality of life after open surgery and endoscopic treatment of Zenker’s diverticulum based on telephone interviews. Patients with achalasia with an esophageal diverticulum who underwent surgery reported their complaints and satisfaction at regular intervals on a scale of 1 to 10.³⁰ In the latter cases, 76% of patients undergoing laparoscopic Heller–Dor surgery and diverticulectomy were satisfied: 31% of them considered improvement in symptoms to be excellent, and 27% considered it to be good. In a long-term study, Rosati et al²⁷ confirmed a permanent asymptomatic condition in 85% of patients undergoing laparoscopic treatment of epiphrenic esophageal diverticula. Zaninotto et al²⁸ considered improvement of more than 50% in the patient symptom score to be successful, and this was the case in 70.8% of the patients.

In our study, we demonstrated that the main complaint shared by our patients was severe and regular dysphagia, which was resolved almost completely by the surgery (mean preoperative dysphagia score 2.5 points, mean postoperative dysphagia score 0.17 points; 93.3% healing); significant improvement was detected in epigastric pain (1.83 points, 0.83 points; 55.5% healing) and in re-

gurgitation (2 points, 0.66 points; 66.6% healing). In contrast, the incidence of GERD increased (1/8, 4/8) after surgery. Postoperative reflux was less severe in most of the cases (and was controlled with drug therapy), although one patient had to undergo reoperation and became completely asymptomatic after Nissen surgery. As a result, the reasoning used by Rossetti et al²⁶ for complete fundoplication should be considered. What explains the fact that Heller–Dor surgery, which provides excellent long-term results in achalasia, is not entirely perfect in the case of a lower-third diverticulum? In our opinion, one explanation may be that excessive mobilization of the esophagus is necessary to perform the diverticulectomy in the case of epiphrenic diverticulum, and natural antireflux mechanisms are therefore impaired.

CONCLUSION

In conclusion, transhiatal laparoscopic diverticulotomy is a safe procedure with all the advantages of minimally invasive procedures. Myotomy and antireflux surgery are essential for permanent and reliable success. After the procedure, a significant improvement is expected in quality of life in the long term, although GERD may develop in some patients.

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